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REPORT ON THE UNITED NATIONS/EUROPEAN SPACE AGENCY TRAINING COURSE FOR EXPERTS FROM ENGLISH-SPEAKING AFRICAN COUNTRIES ON APPLICATIONS OF THE EUROPEAN REMOTE SENSING SATELLITE DATA TO NATURAL RESOURCES, RENEWABLE SOURCES OF ENERGY AND THE ENVIRONMENT

(24 November – 5 December 1997, Frascati, Italy)

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INTRODUCTION

A. Background and objectives

1. The General Assembly, in its resolution 37/90 of 10 December 1982, decided, upon the recommendation of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82), that the United Nations Programme on Space Applications should, *inter alia*, stimulate the growth of indigenous nuclei and an autonomous technological base in space technology in developing countries and promote greater cooperation in space science and technology between developed and developing countries, as well as among developing countries.

2. The Committee on the Peaceful Uses of Outer Space at its thirty-ninth session, held in June 1996, took note of the activities of the United Nations Programme on Space Applications as set out in the report of the Scientific and Technical Subcommittee at its thirty-third session (A/AC.105/637, paras. 26-36). Subsequently, the General Assembly, in its resolution 51/123 of 13 December 1996, endorsed the activities of the Programme on Space Applications for 1997, as proposed to the Committee by the Expert on Space Applications (A/AC.105/625, sect. I).

3. In response to General Assembly resolution 51/123 and in accordance with the UNISPACE 82 recommendations, the Programme on Space Applications included, as part of its activities for 1997, the organization of a Training Course for Experts from English-speaking African Countries on Applications of the European Remote Sensing Satellite (ERS) Data to Natural Resources, Renewable Sources of Energy and the Environment. The Course was the fourth in a series of similar training courses organized for the benefit of French-speaking African countries (1993), Latin American and Caribbean countries (1994) and Asian and Pacific countries (1995).

4. The United Nations/European Space Agency (ESA) Training Course for Experts from English-speaking African Countries on Applications of the European Remote Sensing Satellite Data to Natural Resources, Renewable Sources of Energy and the Environment was organized jointly by the Programme on Space Applications, the Office for Outer Space Affairs and the Department of Economic and Social Affairs of the Secretariat,* in cooperation with the European Space Agency.

5. The objectives of the Course were as follows: (a) to provide participants from English-speaking African countries with a theoretical basis and practical experience in various aspects of microwave remote sensing, focusing on the applications of that technology to natural resources, sources of renewable energy and, in particular, its use in conducting inventories and monitoring the environment; and (b) to familiarize the participants with the operational services of ERS-1 and ERS-2 satellites (for example, data coverage, data sources and product processing levels) and with the bibliography and archives of ERS materials and data that are available at the European Space Research Institute (ESRIN) facility at Frascati, Italy.

B. Organization and programme of the Course

6. The Course was held at the ESA/ESRIN facility from 24 November to 5 December 1997. It was attended by 20 participants from the following countries: Botswana, Egypt, Eritrea, Ethiopia, Ghana, Kenya, Libyan Arab Jamahiriya, Malawi, Nigeria, Uganda, United Republic of Tanzania, Zambia and Zimbabwe. Financial support to defray the cost of international air travel and living expenses of the participants was provided by the Office

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*The former Department for Development Support and Management Services, Department for Economic and Social Information and Policy Analysis and Department for Policy Coordination and Sustainable Development.

for Outer Space Affairs and the United Nations Trust Fund for New and Renewable Sources of Energy. The programme for the Course was developed jointly by ESA and the United Nations (Office for Outer Space Affairs). The lecturers came from ESA, the Space Applications Institute of the European Commission and Eurimage.

7. The Course provided participants with the physical theory on which remote sensing, both active and passive, is based. The Course presented an overall view of remote sensing in various intervals of the electromagnetic spectrum, including the visible, infrared and microwave regions, and highlighted the multi-disciplinary nature of the use of the data. Since the ERS-1 and ERS-2 payloads are composed mostly of active radar instrumentation, the Course emphasized active microwave remote sensing. The Course included the theory and concepts of synthetic aperture radar (SAR) image formation, as well as an introduction to digital image processing of radar data in oceanographic, geologic, hydrological, topographic and cartographic applications. The Course also provided the participants with examples of the applications of the data received from the various instruments on board ERS-1 and ERS-2 satellites, as well as with hands-on experience in digital processing of microwave image products. The complementary information that can be obtained from optical and radar data was stressed as a powerful asset for remote sensing. Presentations made by the lecturers included case studies or projects conducted in Africa. Participants from Kenya, Malawi, Nigeria and Zimbabwe also made presentations on remote sensing data application projects carried out by their national institutions and agencies.

8. The United Nations and ESA utilized the presence of individuals representing institutions from 13 countries in English-speaking Africa to further develop the concept of a technical assistance programme proposal that could support the use of remote sensing technology and data in sustainable development projects in developing countries. That concept had originated during the first course, for French-speaking African countries, held at Frascati in 1993, and further evolved during the second course, for Latin American and Caribbean countries in 1994, and the third course, for Asian and Pacific countries in 1995. The concept discussed by the participants and co-sponsors of the Course is summarized in section I below.

9. The present report, which covers the background, objectives and organization of the Course, has been prepared for the Committee and its Scientific and Technical Subcommittee. The participants in the Course have reported on the knowledge acquired and on the work conducted during the Course to the appropriate government authorities, universities and research institutions in their own countries.

I. POSSIBILITIES FOR THE USE OF REMOTE SENSING TECHNOLOGY IN SUSTAINABLE DEVELOPMENT PROJECTS

10. During the Course, it was noted that, together with satellite systems of other national agencies, the remote sensing satellites of ESA contributed to observing the Earth and its environment in a systematic, global and accurate manner. Through modern technology they provided measurements of physical parameters of the ocean-land-atmosphere system with continuity, compatibility and full coverage, night and day. Where supported by operational ground acquisition stations, they ensured long-term observations and yielded time-series of consistent and calibrated remote sensing data. This allowed the building up of a history of parameters describing a physical phenomenon such as climate. From such a history, characteristics, trends and anomalies of the phenomenon could be identified.

11. It was noted that, given the capability of microwave radiation to penetrate clouds, ERS provided all-weather images of the Earth's surface and allowed the monitoring of surface features even in areas where optical instrumentation failed because of frequent or permanent cloud coverage, such as over equatorial and polar regions. In addition, radar images provided information on surface geometry and humidity that

significantly complemented surface albedo and temperature data provided by optical satellites, making remote sensing observations a powerful and versatile tool for applications to environmental disciplines. The nature of such satellite data was in effect multidisciplinary, since they could be used simultaneously for many applications and different operational requirements. Directly or through ESA services, national institutions could gather and archive the data and, if required, further process them to serve their users in fields as diverse as geology, oceanography, hydrology, meteorology, glaciology, forestry, agriculture, topography, cartography, land use and environmental matters ranging from urban settlement to pollution monitoring.

12. During the courses held at Frascati in 1993, 1994 and 1995, the participants had indicated that two obstacles to the utilization of image products such as those covered in the courses were the lack of access to them and the need for further education on the principles of their use, together with hands-on training to develop experience in the mechanics of analysis. The representatives of the Secretariat and ESA had indicated that they would explore ways and means of providing at least a limited amount of data and further training for the ongoing activities of the participants.

13. After the first course, held in 1993, representatives of the Office for Outer Space Affairs and the former Department for Development Support and Management Services of the Secretariat and ESA discussed the issue and concluded that (a) for the courses to reach their objectives fully, it was essential that participants returning home should have access to satellite data and to the necessary image-processing software in order to strengthen their newly acquired skills; (b) institutions with ongoing projects would be the most likely to need and utilize the data; and (c) a technical assistance programme proposal should be developed by the co-sponsors to support selected ongoing projects of national and regional importance in the areas of natural resources management, environmental monitoring, sustainable development, and disaster reduction and preparedness management by providing necessary technical assistance and related support in remote sensing technology and capacity-building.

14. The development of the programme would include the following three phases: (a) needs assessment to determine the degree of interest of institutions in the regions participating in the programme and the quantities and types of data needed; (b) identification of ongoing projects in Africa, Asia and the Pacific, and Latin America and the Caribbean that are using or could use satellite data; and (c) evaluation and selection of project proposals on the basis of those remote sensing applications that were in greatest demand in the regions concerned. Subsequently, the selected projects would be presented by the co-sponsors, with the endorsement of the participating institutions and their Governments, to potential funding sources. The data provided by the programme would not be limited to ERS-1 and ERS-2 data but, on the basis of project requirements, could originate from other satellites (for example, the Land Remote Sensing Satellite (LANDSAT) and the Satellite Système Probatoire d'Observation de la Terre (SPOT)) or from a combination of satellites in order to take advantage of the complementary nature of satellite-obtained data.

15. During the implementation of the above-mentioned programme, the data needs of several ongoing projects were submitted to the Secretariat (Office for Outer Space Affairs and Department for Development Support and Management Services) and ESA by participants in the first three training courses held at Frascati in 1993, 1994 and 1995. The first series of submissions came from Latin America and were integrated thematically into modules that the co-sponsors could present to potential financial contributors. A similar process was also under way for Africa and Asia and the Pacific, using input received from participants in other training courses jointly organized by the United Nations and ESA in the regions.

16. The above-mentioned programme was presented to the participants in the Course held in 1997, with an invitation to participate in the project and to contribute to the first two phases of the programme. The participants expressed great interest in the offer. A number of discussions took place during the Course in order

to consider the issues related to phases (a) and (b) described in paragraph 14 above. The United Nations and ESA provided additional information and assisted the participants in the discussions.

17. During the discussion on possible follow-up projects at the conclusion of the Course, the participants emphasized that ERS data could provide a very useful input for applications to the monitoring of natural resources, renewable sources of energy and the environment. They identified a number of projects of national or regional importance that could benefit from ERS data, including the following: (a) land-degradation monitoring in the Horn of Africa (Eritrea, Ethiopia); (b) environmental degradation in the Lake Victoria area (Kenya, Uganda, United Republic of Tanzania); (c) sedimentation monitoring of Lake Volta (Ghana); (d) use of interferometry for developing digital elevation models (DEM) in the Sahara (Egypt, Libyan Arab Jamahiriya, Morocco, Tunisia); (e) desertification, soil erosion and land degradation in the Sahara (Egypt, Libyan Arab Jamahiriya, Morocco, Tunisia); (f) application of remote sensing data to groundwater and river basin monitoring in the Horn of Africa (Ethiopia, Malawi); (g) coastal area monitoring (Nigeria); (h) rehabilitation and conservation of savannah woodland using multi-temporal SAR data; and (i) development of on-farm techniques for management of soil erosion and landslides in east Africa (Kenya, Uganda, United Republic of Tanzania). Some of the projects were ongoing and involved the institutions and agencies of the participants.

18. In discussing issues related to availability, accessibility and practical applications of ERS data, the participants noted, among other things, that present and potential users of the data should be more exposed to and trained in the basic sciences underlying microwave remote sensing technology so that they could more fully implement the technology and utilize the relevant data. The limited availability of data and the lack of appropriate hardware and software needed for ERS data processing were the other obstacles to the routine utilization of radar images. It was also noted that combining ERS radar data with optical data would speed up the adoption of microwave technology, by supplementing existing operational methods of optical remote sensing. That would assist in overcoming the cloud-cover problem in the region, and the complementary data would be especially useful in such applications as map updating, temporal monitoring and hazard assessment.

19. The United Nations and ESA informed the participants that the co-sponsors would conduct, on the basis of submissions received from the institutions and agencies of the participants, a needs-assessment survey for the region and an evaluation and selection of project proposals as a preparatory phase in the process of developing the technical assistance programme referred to above. The participants were also informed of project-selection criteria, which included the following: (a) relevance to development issues; (b) impact of limited resources; (c) government and participant commitment; (d) human resource development; (e) potential to obtain early results; and (f) medium-term duration.

20. In order to facilitate a fair process for evaluating and selecting the project proposals, using a common set of criteria, it was suggested that submissions of institutions and agencies of the participants should be prepared in a standard format based on the model used by the United Nations Development Programme. In that respect, the co-sponsors distributed among the participants comprehensive guidelines for the preparation of project proposals.

II. SUMMARY OF PRESENTATIONS

21. The training programme offered in the Course was similar to that of the courses organized for the benefit of French-speaking African countries in 1993, Latin American and Caribbean countries in 1994 and Asian and Pacific countries in 1995. A detailed overview of topics presented at the Course can be found in the report on the United Nations/European Space Agency Training Course for Latin American and Caribbean Countries on the Monitoring of Natural Resources, Renewable Sources of Energy and the Environment Using Data from the European Remote Sensing Satellite (ERS-1) (A/AC.105/594).

III. CONCLUSION AND RECOMMENDATIONS

22. During the discussion at the conclusion of the Course, the participants expressed their commitment to following up the work relating to the technical assistance programme to be carried out by the United Nations and ESA. In that respect, they would inform the authorities of their institutions and agencies regarding the objectives, goals and expected results of the programme, and would initiate the preparation of project proposals based on ongoing projects of national and regional importance in the areas of natural resources management, environmental monitoring, sustainable development, and disaster reduction and preparedness management.

23. The participants made a number of recommendations, which may be summarized as follows:

(a) Subject to funding availability, the series of United Nations/ESA Training Courses on ERS Data Applications should continue in order to expose experts and natural resources managers from developing countries to various aspects of current and future microwave remote sensing systems and applications of ERS data to natural resources exploration and environmental monitoring;

(b) The duration of the Course should be extended by three or four weeks to allow sufficient coverage of the large amount of information on theory and applications of microwave remote sensing, as well as to allow for more extensive practical training in image processing and analysis;

(c) The United Nations and ESA should continue their support of regional conferences and workshops on microwave remote sensing applications, where participants could be updated on a regular basis (biannually) on the latest developments in this rapidly expanding technology, as well as share information on national projects and programmes and foster regional cooperation.

24. The participants expressed their appreciation for the technical quality of the training programme delivered to them, for the fellowships received from the co-sponsors, which had made their participation in the Course possible, and for the cooperation and support that they had received from the administrative and technical personnel of ESRIN.